Graphics in Windows 7

DirectX and WDDM Advances

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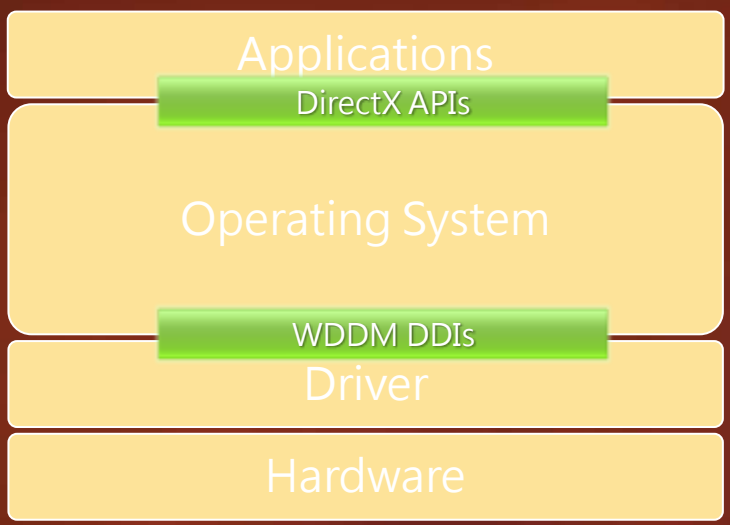
Talk Overview

- Understand the changes in the Graphics subsystem in Windows and how they are reflected in the DirectX APIs and WDDM DDIs
- New requirements for Windows Graphics
- Evolution of the DirectX APIs
  - Changes to existing APIs and new APIs
- WDDM DDI changes

Overview



DirectX Evolution

- Originally designed for Games and to abstract HW
- DX9 introduced Floating point shaders
  - HLSL to program shaders
  - Windows Vista adopted it for many features:
    - UI: Aero and MCE
    - Image Processing: Windows Photo Gallery
- DX10 was designed for more than games
  - Clean API to minimize API overhead
  - Consistent implementation across HW - No Caps
  - Refactored Infrastructure API: DXGI

DirectX == High Performance Graphics

Broad Usage of Direct3D Today

- Typical user is someone who needs great performance and very custom/rich rendering
- Mapping applications:
  - Eg. VirtualEarth and Google Earth
- UI and Application Frameworks:
  - WPF, XNA
- User Interfaces:
  - MCE, Zune, DWM
- Workstation Applications:
  - Eg. Dassault Systèmes-3DLive, AutoDesk Applications, Bentley Microstation, SoftImage XSI

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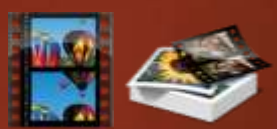
Elements of Graphics

3D



Video and Images

2D

Segoe UI

Text

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Evolving User Experiences

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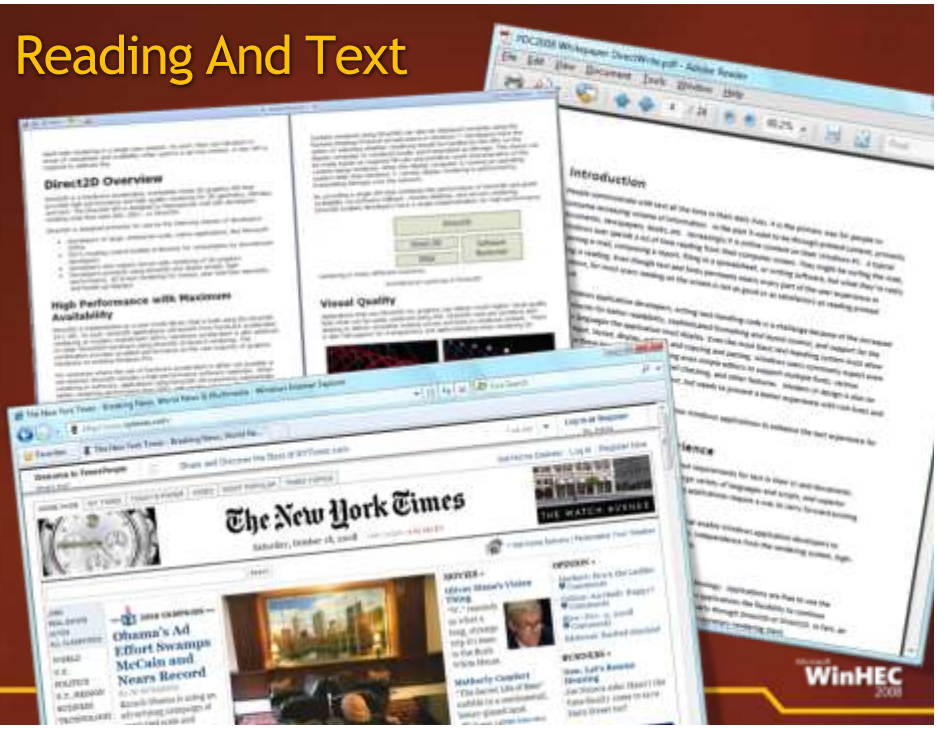
Reading And Text



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GPU Evolution

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Server Rendering

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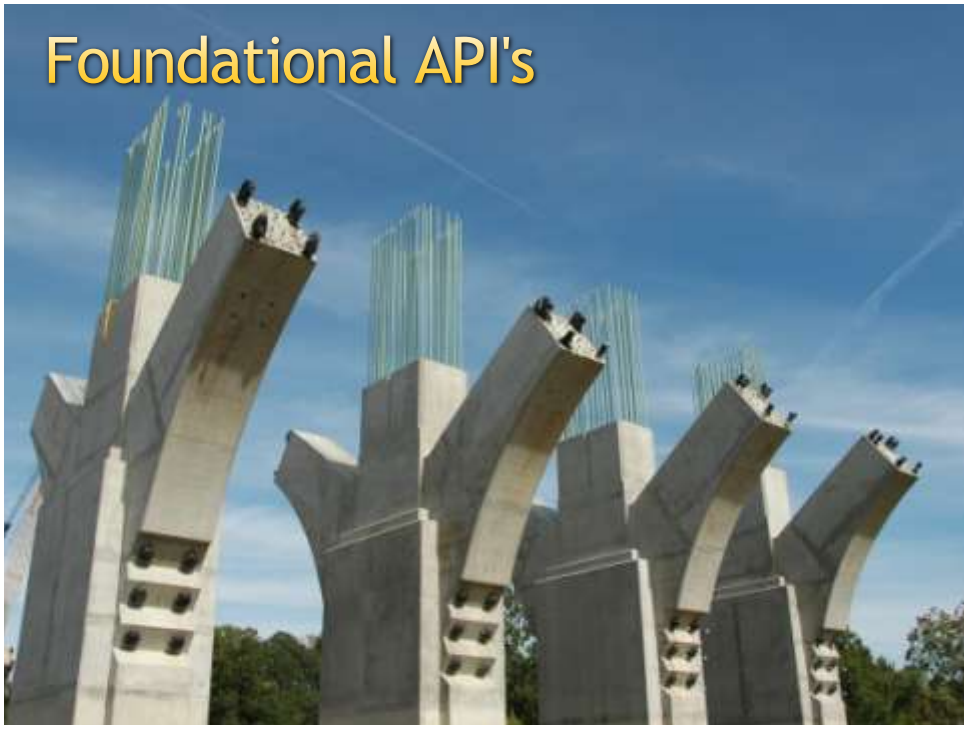

Mainstream Developer Needs

- Performance
  - Frame rate
  - Startup time and working set
- Interoperability
  - Plug-ins
  - Partial migration
- Software fallback
  - Server-side rendering
  - More consistent results
- Remote display

Current Platform Challenges

Area	Existing API(s)	Challenges
3D	D3D3…D3D10	Not always available: •No HW •Server •Remoted
2D	GDI, GDI+	Quality, Performance
Text	GDI	Quality, Not up to date
Imaging	GDI, GDI+, WIC	Extensive format support, Security
Device Control	GDI	Outdated notion of HW config

Advancing the platform

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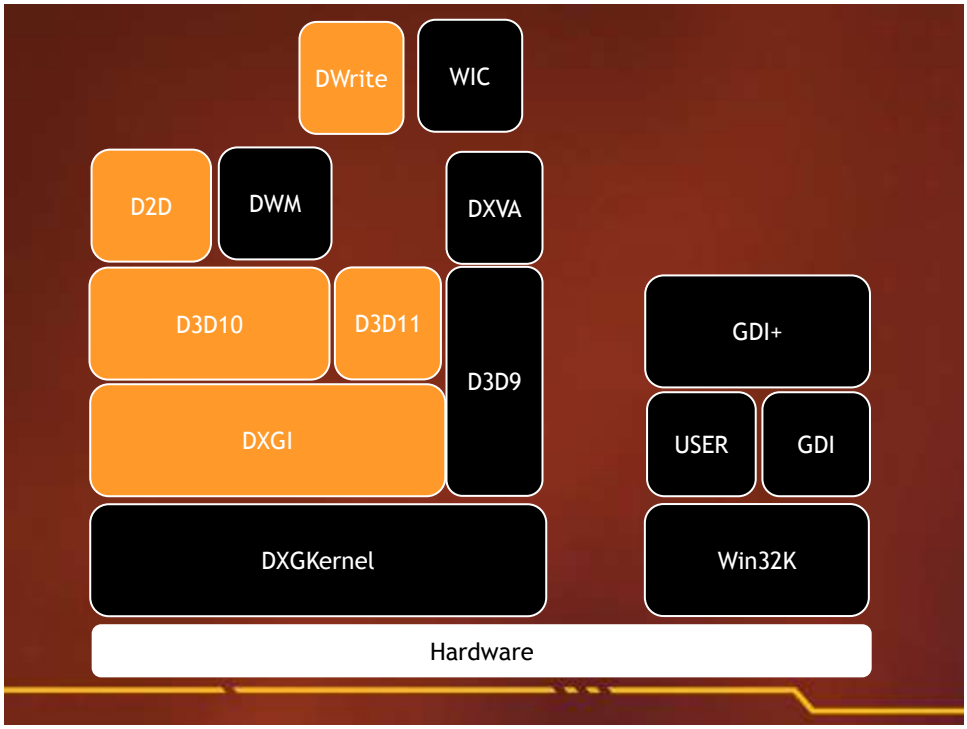
Advancing the platform

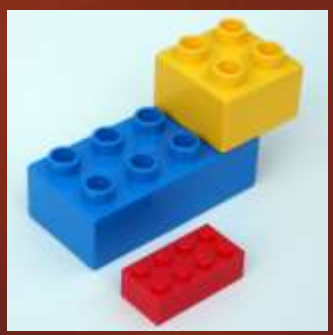
Introducing…

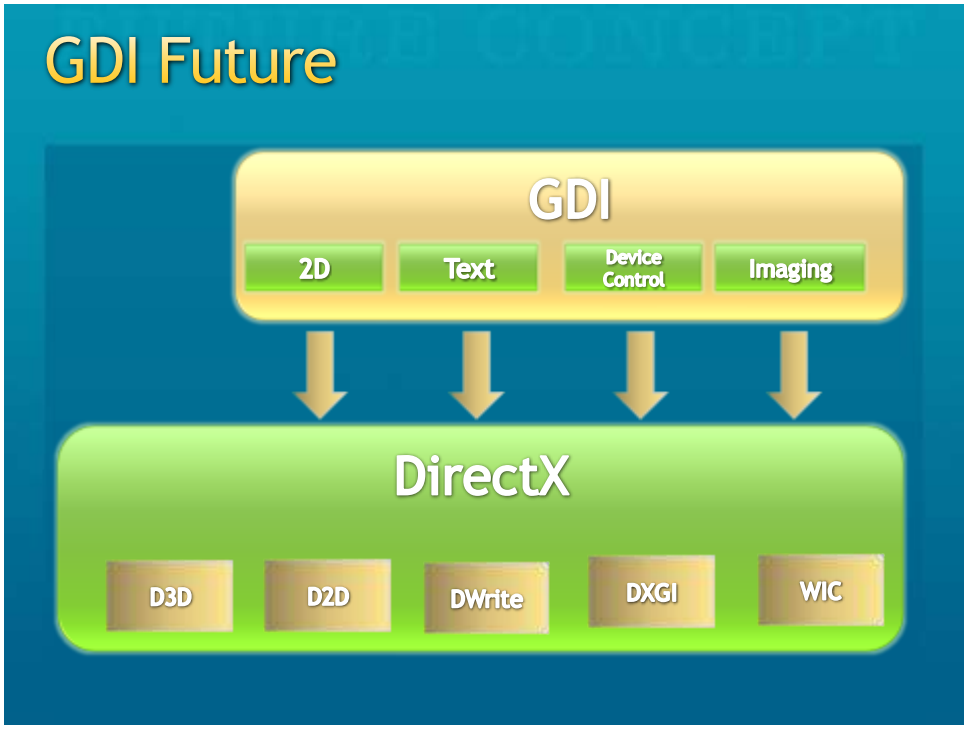
Direct2D
DirectWrite

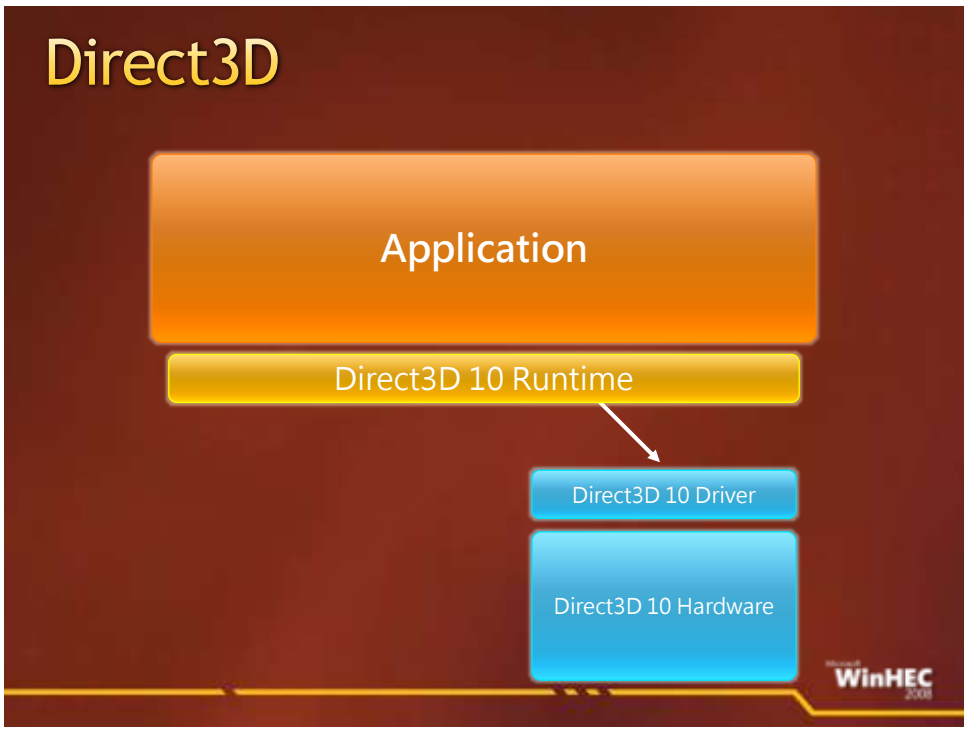


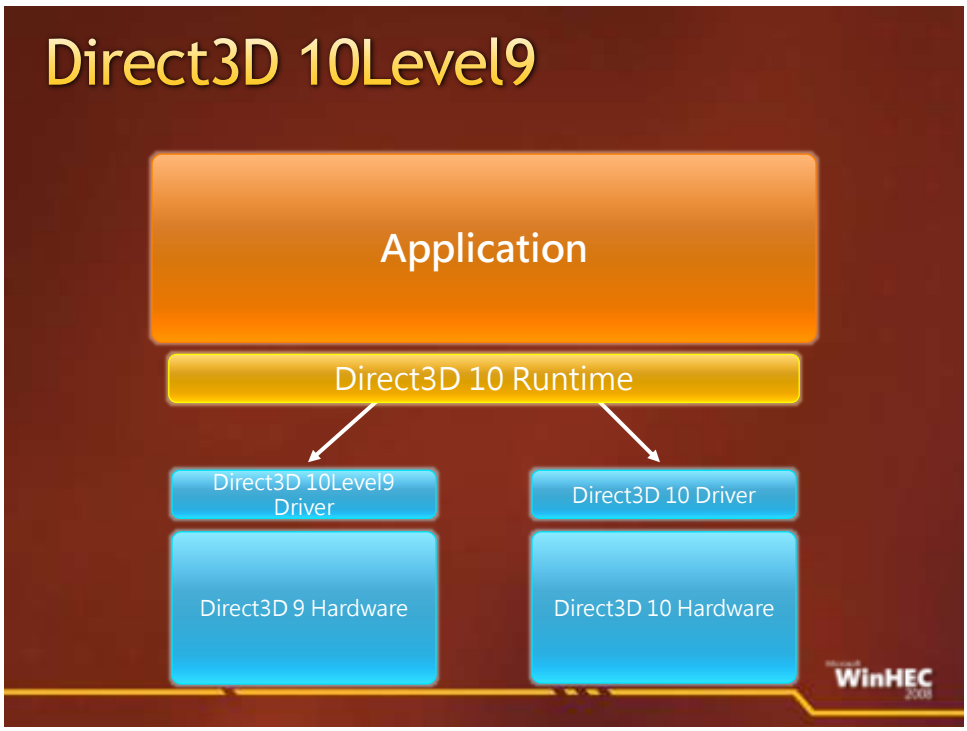
Properties of DirectX APIs

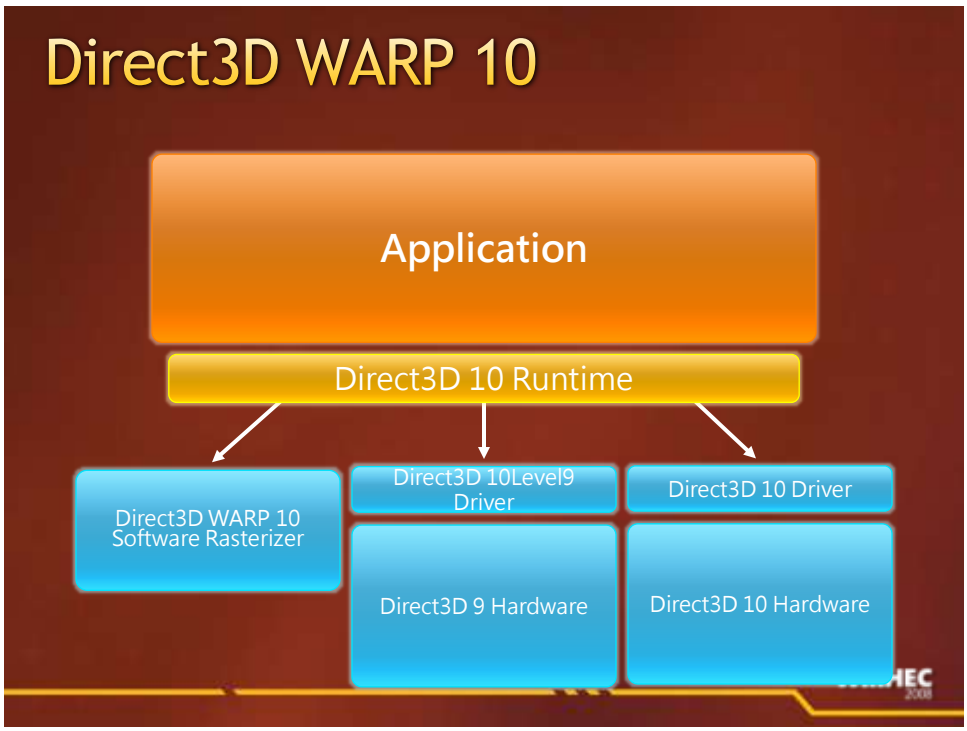
- Primary focus:
  - Large scale Win32 application developers with existing codebases
  - Designed around needs of Windows UI, Internet Explorer, Microsoft Office
- Side-by-side components
  - Can mix-n-match
- Interface based APIs w/ C/C++
- Hardware accelerated
- Immediate mode rendering
- Interops with older Win32 APIs
- Available on Windows Vista











Our Criteria for WARP Development

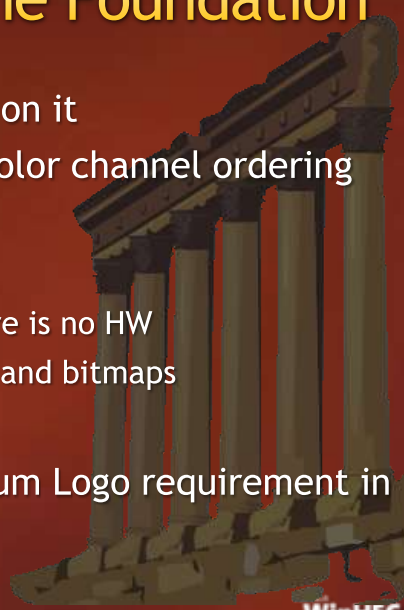
- 100% conformant with Direct3D10 Spec
- Performance
  - Hundreds of times faster than RefRast
  - Fast enough for real-time use

Remoting On Direct3D 10.1 API

- Remote Adapter
  Application opts into primitive remoting
  - Bitmap remoting otherwise
  - More details in: **Presentation Virtualization: Graphics Remoting (RDP) Today and Tomorrow**

Direct3D 10.1 is the Foundation

- DWM in Windows 7 is built on it
- Supports GDI compatible color channel ordering
- Always available:
  - D3D10L9 for DX9 HW
  - Full SW emulation when there is no HW
  - Fully remoted via primitives and bitmaps
- Direct3D 10 HW is a Premium Logo requirement in Vista



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Introducing Direct3D 11

Microsoft Confidential

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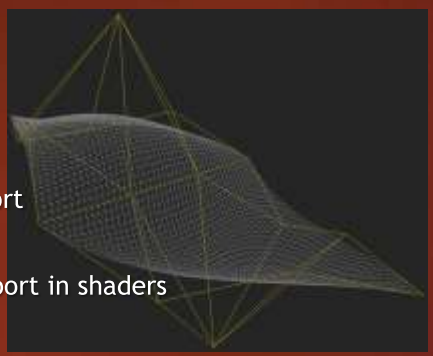
Direct3D 11: Increasing GPU Utility



- Strict superset of Direct3D10
- Runs on Direct3D 9, 10 and 11 HW
- New Graphics features
  - Improved multi-threading support
  - (Need new HW) Tessellation
  - (Need new HW) Subroutine support in shaders
- **Compute Shader Enables non-Graphics usages (GPGPU)**
  - **Integrated with graphics for imaging usage**
  - **Program with familiar HLSL and D3D resource model**

DX11 Details

- DirectX 11: Solutions for Graphics and Data Parallel Computing
  - David Blythe

Features: Direct2D

- Rendering focused
  - 2D vector graphics, bitmaps, and text
  - Hardware or Software
- Other Services
  - Display/Device handling → DXGI
  - Printing → XPS
  - Image Encoding/Decoding → WIC
  - Text Formatting → DirectWrite

Features: Direct2D

- Interoperability
  - GDI
  - Direct3D
- Performance
  - Built on Direct3D 10.1
  - Lower CPU usage than GDI/GDI+
- Visual Quality
  - Alpha Blending
  - Per-primitive anti-aliasing
  - MSAA via Direct3D interoperability

Features: DirectWrite

- Modern Typography
  - Full OpenType Support
- Enables world-wide applications
- ClearType
- Works with any rendering technology
- Hardware accelerated with Direct2D

DirectWrite Rendering
Flexibility and performance

- Rendering can be performed using DirectX, GDI, or other technologies
- Up to **2X faster** layout performance than GDI
- **Hardware accelerated text with Direct2D**
  - ClearType filter and blend performed in hardware
  - Enables app-level hardware caching optimizations
  - Reduced CPU usage in Windows OS components when drawing glyphs

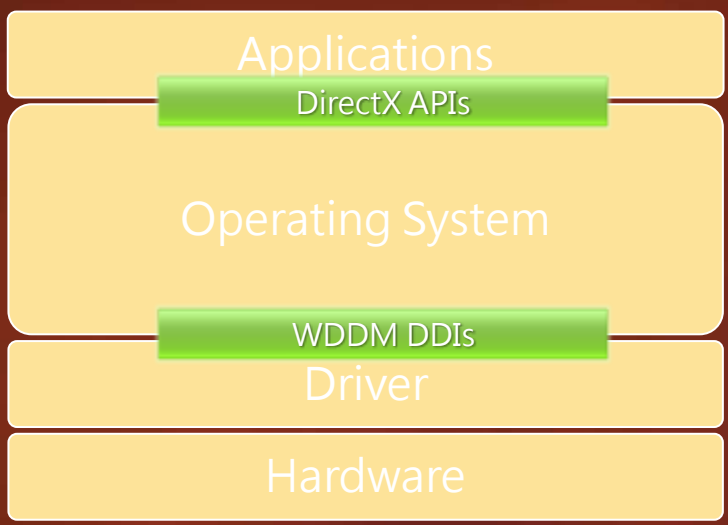
API Interop

- All DirectX APIs interoperate with each other.
- IDXGISurface is the common interchange between these APIs
- Direct3D 11 and Direct3D 10 interoperate via synchronized shared surfaces
- Direct2D and Direct3D 10/11 interoperate at the Device as well as at Surface Level
- WIC and DirectWrite can be used with any API
- GDI interoperates with D2D and D3D

DirectX Summary

- Originally DirectX was designed for Gaming
- Over time DirectX has become synonymous with Graphics
- Windows UI and many other applications use DirectX
- DirectX 10 has become the baseline API for Windows
- Two new DirectX APIs are introduced

Overview



Display Driver Evolution

- XPDM – Introduced in NT 4.0 and evolved till Windows XP
  - Single application using the GPU at a time
    - Optimized for Gaming
  - GDI Acceleration
  - No Memory protection or isolation
  - No recovery from HW hangs
- WDDM – Introduced in Windows Vista
  - Multiple Applications sharing the GPU
  - Recovery from HW hangs
  - No GDI Acceleration

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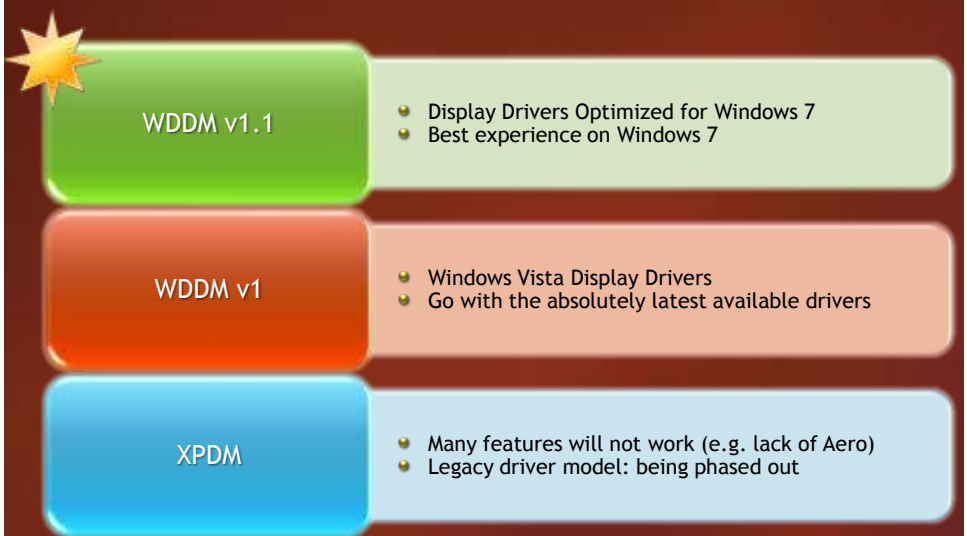
Display Drivers In Windows 7



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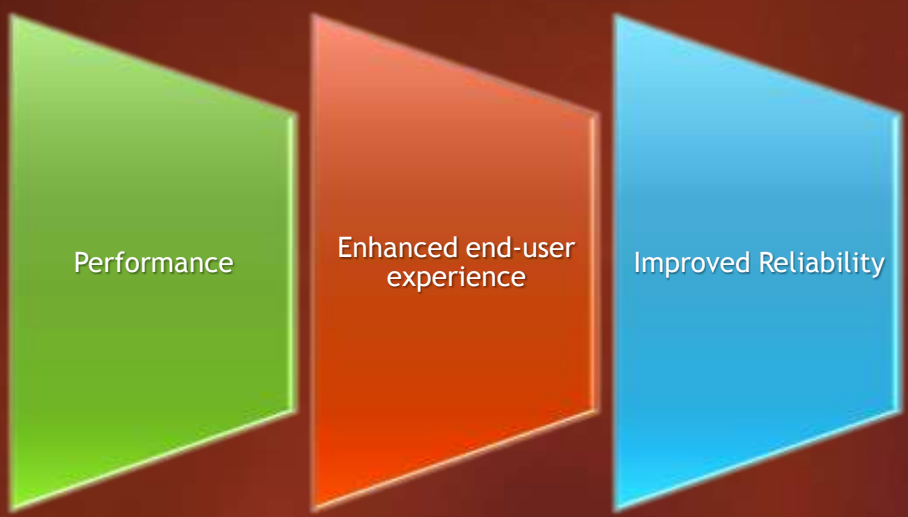
Overview Of WDDM v1.1

- "v1.1" - Incremental Driver Model change
  - Set of DDI changes for WDDM drivers
- WDDM v1.1 Feature Set
  - Required capabilities
  - Optional capabilities
- Required for Windows 7 Logo

WDDM v1.1 Feature Set



WDDM v1.1 Feature Set

Performance

- System memory savings for running Aero
- High-performance Direct3D10 Aero Glass Windows desktop
- Performant Direct2D API
- Performance gains in gaming scenarios

Enhanced end-user experience

Improved Reliability

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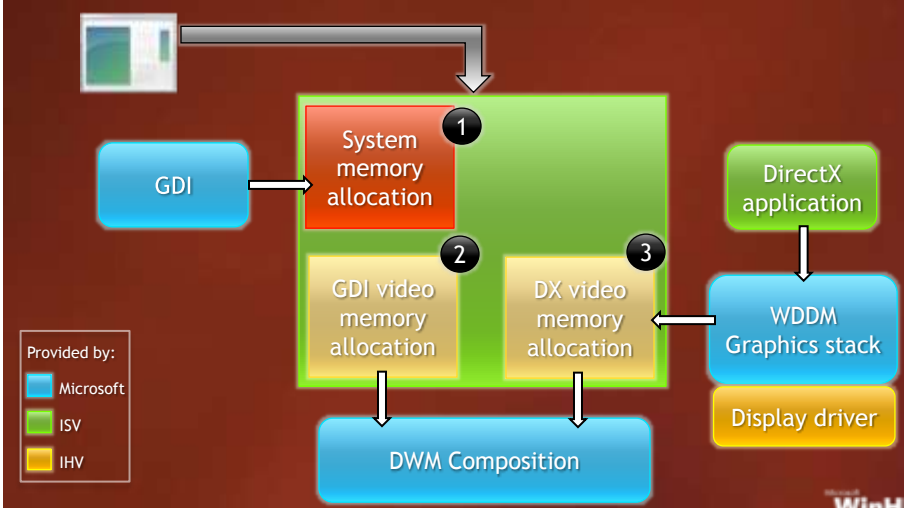
Memory Usage In Windows Vista

Case 1 – Window with both GDI & DirectX content



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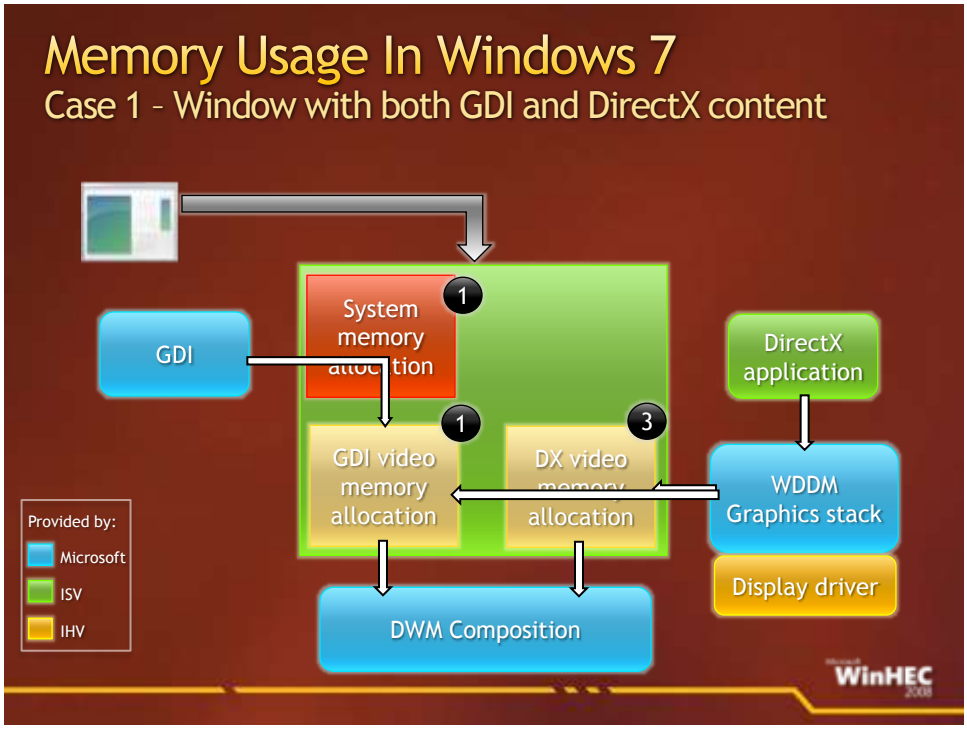
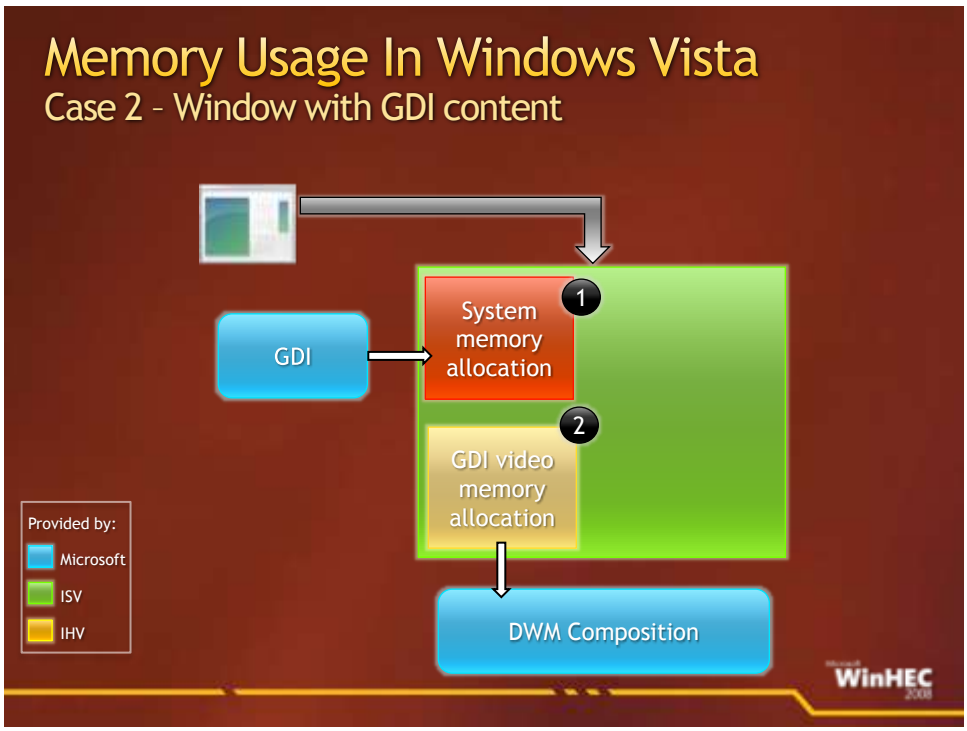
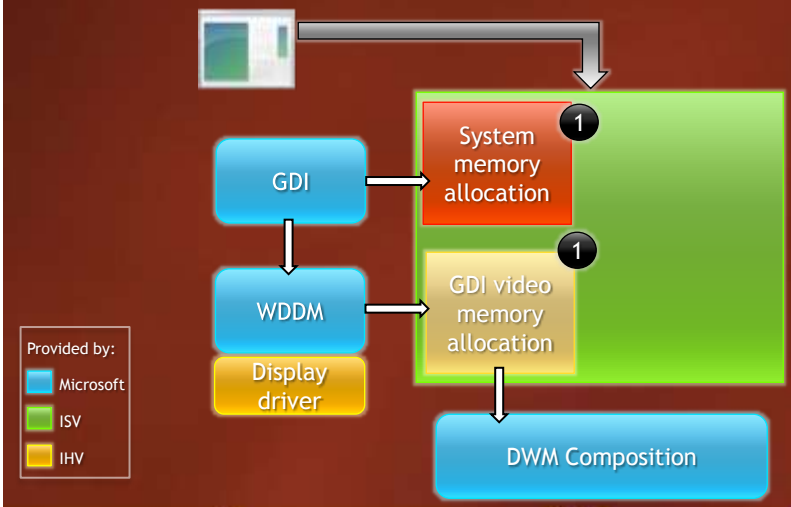




Memory Usage In Windows 7

Case 2 – Window with GDI content



Memory savings

GDI Application windows

- More open windows, more savings
- Memory Saving: One system memory surface per window

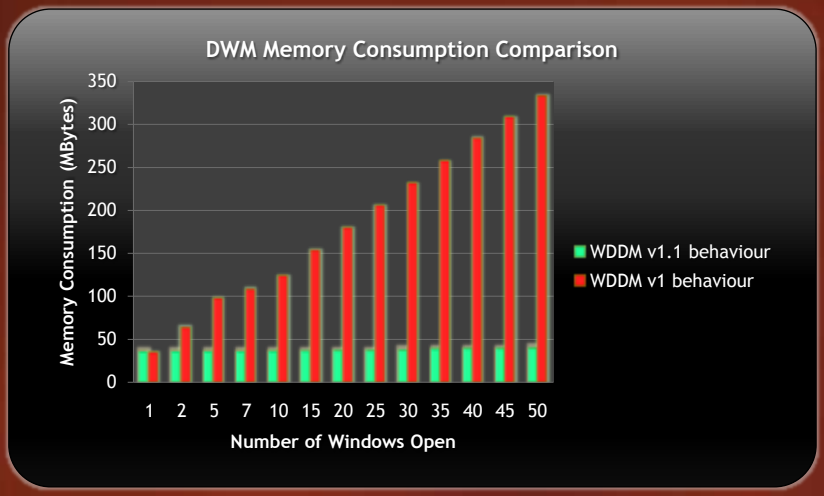
{System memory consumed by 1 window} = {Horizontal screen resolution} X {Vertical screen resolution} X 4 Bytes

# of Windows ---------- Screen Resolution	5 windows	15 windows	30 windows
1024 x 768	15 MBytes	45 MBytes	90 MBytes
1280 x 1024	25 MBytes	75 MBytes	150 MBytes
1600 x 1200	36.5 MBytes	109.5 MBytes	219 MBytes

WDDM v1.1 Requirement
GDI Hardware Acceleration Interfaces

- Support for common 2D operations:
  - Drawing operations:
    - BitBlt, ColorFill, AlphaBlend etc
  - Cleartype font support
- Support for common ROPs
- Support for Linear Heaps
- Texture size of 8K X 8K

Results



Note: The above data compares system memory consumption only.
Preliminary data gathered on Windows 7 pre-release builds and subject to change

WDDM v1.1 Feature Set

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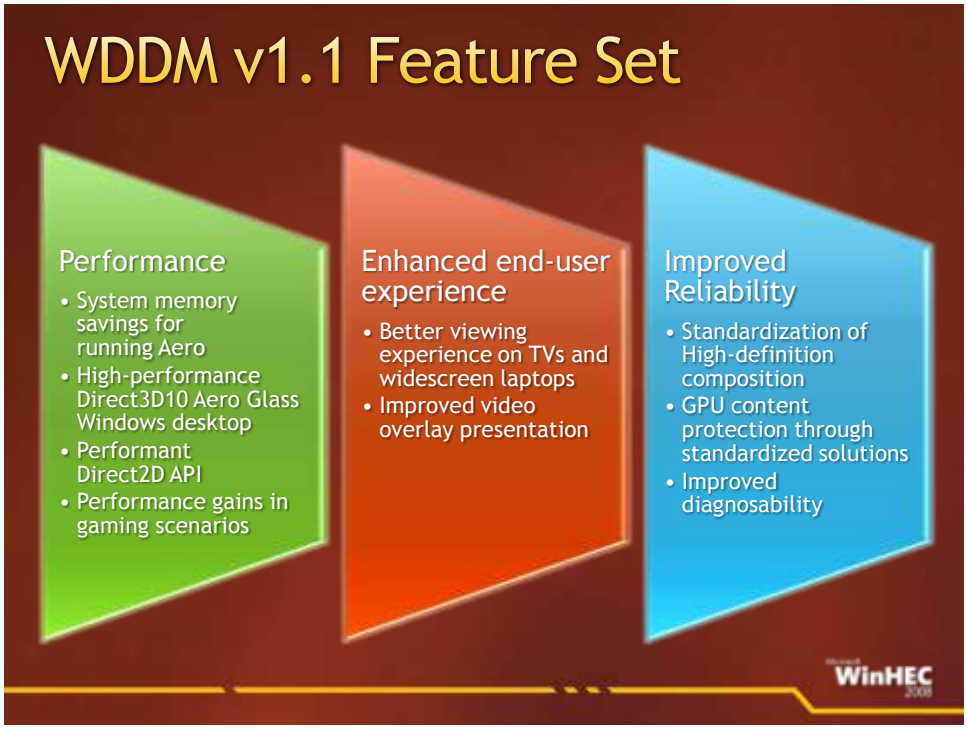
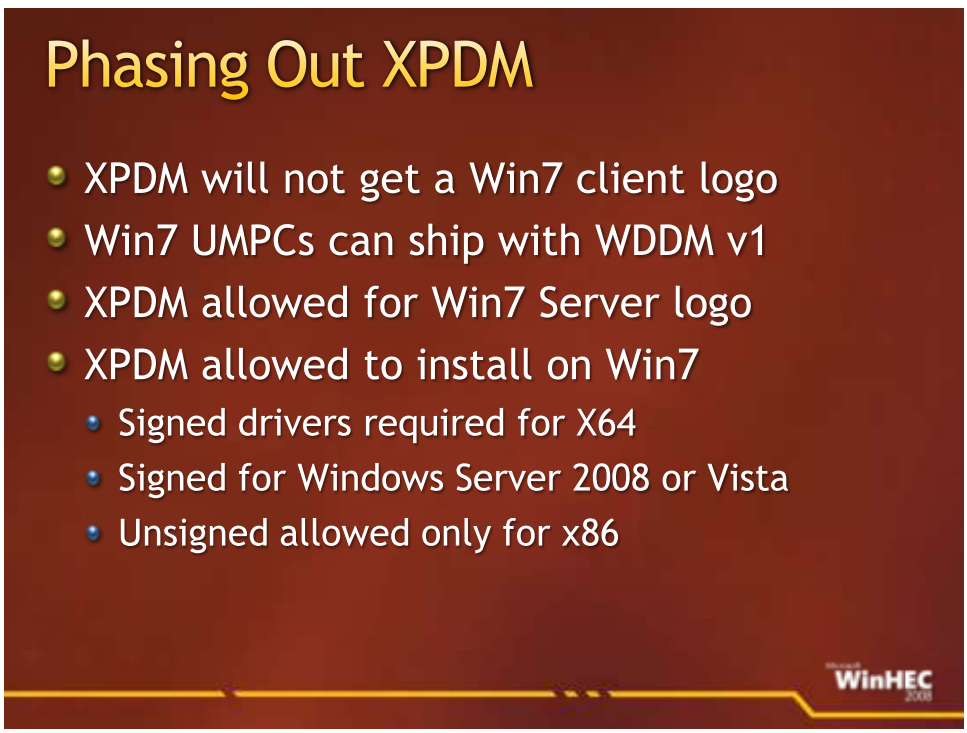
Enhanced end-user experience

- Better viewing experience on TVs and widescreen laptops
- Improved video overlay presentation

Improved Reliability

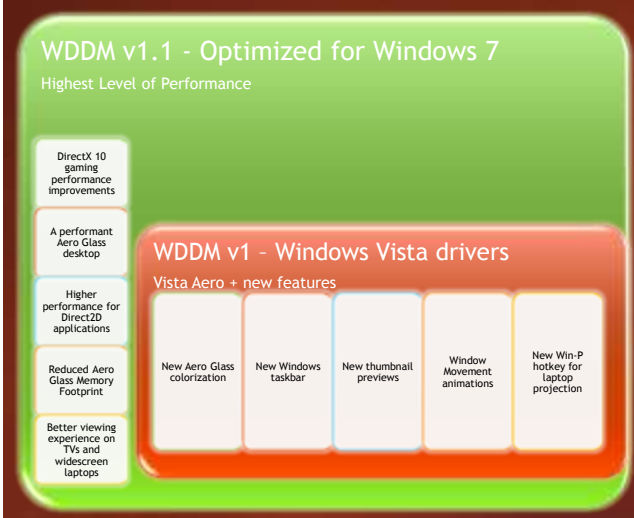




Proposed Logo Requirements

Windows 7 Feature Name	WDDM v1.1 Feature Requirement	Mandatory/Optional Requirement
System Memory Savings for Aero	GDI Hardware Acceleration	Mandatory
High Performance Desktop running on Direct3D10	BGRA support	Mandatory
A Performance Direct2D API layered over Direct3D10	BGRA support	Mandatory
A better viewing experience on TVs and widescreen laptops	CCD DDI	Mandatory
Improved diagnosability of stability problems	VSync Data Reporting	Mandatory
Improved diagnosability of performance problems	FPO Disable	Mandatory
Specifies method of encryption that should be performed for premium content over the UAB	Standardized AES 128 support	Optional
Standardized mechanism for High-Definition composition through DXVA-HD	DXVA-HD DDI	Optional

Graphics User Experience



DirectX version	WDDM version	Graphics hardware
DirectX 10.x	WDDM v1.1	nVidia: GeForce 8300, 8400, 8600, 8800 (G80, G8x family) AMD: Radeon HD 2xxx and newer; FireGL V6xxx\V8xxx and newer Intel: i4G, i45GM, G35, i965GM and newer
DirectX 9	WDDM v1	nVidia: GeForce 6xxx and 7xxx AMD: Radeon 9800, X300 – X1900 series Intel: i965, i950, i945, G3x

Call To Action

- Build systems with DirectX 10.x/11 GPUs
- Test with pre-release WDDM v1.1 drivers
- Test custom driver packages for mobiles
- Test DirectX games with WDDM v1.1 drivers
- Refer to Win7 proposed Logo requirements
- Test variety of hardware configurations
- Maintain complete 64-bit parity

Additional Resources

- Web Resources
  - Whitepapers: http://www.microsoft.com/whdc/display
  - Other Resources: http://msdn.microsoft.com/directx
- Contact information
  - Directx @ Microsoft.com